and transparent, are found. The three characteristic varieties of the latter are a clear yellow gem spodumene of Brazil,* the green hiddenite or 'little emerald' of North Carolina,† and the lilac sometimes found in Connecticut.‡ These are without doubt remnants of large specimens, which must have been elegant. Spodumene is very subject to alteration and has usually lost all its transparency and beauty of tint.

Kunz (*loc. cit.*) described some large and magnificent crystals of unaltered spodumene, of rich lilac color, which have recently been discovered near Pala, San Diego County, California, in connection with certain other lithia minerals. It has been my good fortune to see and handle from this locality massive spodumene crystals ($10 \times 20 \times 4$ cms.) perfectly clear, of a rose lilac tint, varying with the spodumene dichroism, from a very pale tinge when observed transversely to the prism, to a rich amethystine hue longitudinally. No such crystals of spodumene have ever been seen before and the discovery is of great mineralogical interest. The crystals have been etched by weathering and have a twinning like the hiddenite variety. The mineral, when cut and mounted parallel to the base, gives gems of great beauty. The chemical analysis, which is under way in my laboratory, will shortly be published.

The observations of Dr. Kunz sufficiently characterize this mineral of peculiar beauty as a new gem, which he has not named. I have submitted large crystals to the action of ultra-violet light without any evidence of fluorescence or phosphorescence. When subjected to bombardment of the Röntgen rays of high penetration for several minutes no fluorescence is observed, but on removal to a dark chamber it exhibits a persistent white luminosity not observed with this class of minerals, as learned by experiments with altered and unaltered spodumene from the localities mentioned, including cut stones and such handsome crystals of hiddenite as afforded by the collections mentioned. I have been able to excite a crystal ($2 \times 4 \times 10$ cms.) by the action of the X-rays for five minutes sufficiently to cause it to photograph itself when subsequently placed directly upon a sensitive plate (thin white paper being interposed) and allowed to remain in an especially constructed padded black box in a dark room for a period of ten minutes. The material is penetrated by the rays as shown by a cathodograph. The excitation is not superficial, but persists throughout the mass. On account of this unusual and characteristic phosphorescence, as well as the other properties, I propose the name *Kunzite,* for reasons unnecessary to give to American and European scientific men. The mineral material and cut gems may be seen at Tiffany and Co.'s or the American Museum of Natural History, New York.

CHARLES BASKERVILLE.

August 12, 1903.

* Pisani, *Comptes Rendus*, 84, 1509, 1877.

† J. L. Smith, *Am. J. Sci.*, 21, 128, 1881.

‡ Penfield, *Am. J. Sci.*, 20, 259, 1880.

THE TOXIC EFFECT OF H AND OH IONS ON SEEDLINGS OF INDIAN CORN.

WITHIN the last five years or so some attempt has been made to determine the toxic effect of various chemical solutions upon plant life. This involved the theory of ionization, which is based upon the electrical conductivity of solutions.

When acids, bases or salts are put into solution, they separate, more or less completely, into molecules or part molecules of their elements, or into groups of two or more atoms of different elements which are very strongly united. Molecules which exist in this state are known as ions—*e. g.,* if 100 molecules of HCl were put into solution they would separate to form H ions and Cl ions, and probably there would be some HCl ions left, depending upon the strength of the solution. If $NaOH$ were put into solution a like separation would take place except that OH ions and Na ions would be formed in place of the H ions and Cl ions.

All compounds do not permit total dissociation at the same dilution. "Solutions of hydrochloric, nitric and sulfuric acids are nearly completely dissociated when an equivalent in grams is dissolved in 1,000 liters of

water."* "Solutions of hydrochloric, nitric and sulfuric acids are practically completely dissociated when an amount of these compounds in grams equal to their molecular weights divided by the number of H atoms (one gram equivalent) is added to one liter of distilled water."†

These statements are contradictory. Though the former states HCl is nearly completely dissociated at $n/1000$ and the latter states that the same acid is practically completely dissociated at a normal solution, yet both are incorrect; but to be exact it is also practically completely dissociated at a concentration four times $n/1000$ dilution, $n/250 = 98.9$.‡

Other weaker compounds may have some undissociated ions—*e. g.*, NaCl at a certain dilution is 80 per cent. dissociated; that is, if there were 100 molecules of NaCl and 80 per cent. of them were dissociated there would be 80 Cl ions and 80 Na ions and 20 NaCl ions.

The degree of dissociation increases as the dilution increases until a dilution is reached when the dissociation is practically complete.

Since the degrees of dissociation in compounds capable of dissociation vary with the dilution, it is necessary to find the degree of dissociation before it is possible to determine the exact toxic effect of each kind of ions in the various solutions—*e. g.*, if a seedling just lives in a solution of KOH 1/128 gram equivalent dissolved in distilled water and made up to 1,000 c.c., and dies in a NaOH solution of the same dilution, one of two things must be true,—either the degree of dissociation in KOH is less than the degree of dissociation in NaOH at the above-named dilution or the Na ions have an appreciable toxic effect at this dilution, but it has been stated by MacDougal§ that at such weak dilutions sodium salts have no appreciable influence, hence the difference in the toxic effect of the two solutions must be due to the difference of dissociation.

It has been stated that it is the H ions and those containing H which are fatal.*

It is the object of the following experiment to find in what dilution KOH, NaOH, HCl and H_2SO_4 seedlings of Indian corn (*Zea Mais*) will be killed, and deduce facts concerning the toxic influence of H and OH ions upon these seedlings.

In order to be clearly understood in regard to terms used it might be well to give some quotations regarding them.

Gram-Molecule (Arrhenius, p. 9).—"Thus, for example, the molecular weight of HCl is 36.46, and consequently 1 gram-molecule of this (HCl) is 36.46 grams, that is, the equivalent weight in grams; a gram-molecule of sulfuric acid is 98 grams, *i. e.*, twice the gram equivalent."

Gram-equivalent (Arrhenius, p. 9).—"By a gram-equivalent of zinc we mean 32.7 grams of this metal; a gram-equivalent of a substance whose equivalent weight is *E* is *E* grams." Thus we see that a gram-equivalent of a monobasic substance is equal to its molecular weight, and of a dibasic substance is equal to one half its molecular weight.

Normal Solution (Sutton, p. 28).—"Normal solutions are prepared so that one liter of solution at 16° C. shall contain the hydrogen equivalent of the active reagent in grams (H = 1)." Fresenius (p. 687): "Solutions of such strength that 1,000 c.c. contains an amount of acid or base equivalent to one gram of hydrogen are normal solutions, *e. g.*

	Mol. wt.	Wt. in 1,000 c.c. of solution.
HCl	36.46	36.46
H_2SO_4	98.00	49.00
Na_2Co_3	106.08	53.04

The normal solutions used in this experiment were made according to the definitions of normal solutions by Sutton and Fresenius.

Tests in this experiment were made with each of four different dilutions of four different solutions, two of alkali, KOH and

* Kahlenberg and True, 'On toxic action of dissolved salts and their electrolytic dissociation,' *Bot. Gazette*, 22: 81, 1896.

† MacDougal's 'Text-Book of Plant Physiology,' 1901, p. 53, par. 78.

‡ Arrhenius, 'Text-Book of Electro-Chemistry,' p. 135.

§ 'Text-Book of Plant Physiology,' 1901, p. 53, par. 78.

* *L. c.*, p. 53, par. 78.

NaOH, and two of acid, HCl and H_2SO_4. The alkali solutions were $n/32$, $n/64$, $n/128$ and $n/256$. The acid solutions were $n/256$, $n/512$, $n/1,024$ and $n/2,048$.

The corn, which was chosen on account of its rapid growth and its straight main root, was soaked twenty-four hours, then put into a germinator containing sphagnum and allowed to remain forty-eight hours until the main roots were about 15 cm. long.

The tests were made in test glasses with a capacity of about 60 c.c. These glasses were thoroughly cleaned before using. Before the tests were made with the alkali the glasses were first washed with normal HCl, then with normal solution of the alkali used in the test, then they were washed and rinsed with water, then rinsed with distilled water, then with some of the solution used in the test. Before the tests were made with the acids the glasses were cleaned by the same process except that they were washed first with alkali solution then with acid solution.

The glasses were filled two thirds full of the solution to be used and labeled, then the seedling was taken from the germinator, carefully removing all the sphagnum; the grain was wrapped in dry cotton wool and fitted firmly in the top of the test glass, but not touching the solution, but the main root reached into the solution at least 10 cm. On the outside of the glass exactly opposite the tip of the root a dot was made with india ink, always holding the tip of the root in a line horizontal to the eye and sighting through the middle of the glass while marking.

The glass and seedling were then put into a dark chamber at a temperature of from 20° to 30° C. for twenty-four hours, after which the growth or elongation was measured. Then the seedling was removed, lightly washed with distilled water and put into a thoroughly cleaned glass with distilled water and allowed to remain in the dark chamber for another twenty-four hours, after which it was again measured.

The tests were started at 10 A.M. The four dilutions of one solution were carried on at the same time.

The results of the experiments were as follows:

TABLE I. SOLUTIONS OF KOH. BEGUN MAY 21, 10 A.M., CLOSED MAY 23, 10 A.M.

Concentration.	Growth in m/m.	Remarks.	Distilled.	Growth in m/m.	Remarks.
$n/32$	0	Flabby, dead.	H_2O	0	Flabby, dead.
$n/32$	0	Flabby, dead.	H_2O	0	Flabby, dead.
$n/64$	3	Yellowish. Probably only elongated.	H_2O	0	Root tip coagulated, dead.
$n/64$	1	Probably only elongated.	H_2O	0	Root tip coagulated, dead.
$n/128$	10	Natural appearance.	H_2O	15	Natural, alive.
$n/128$	7	Natural appearance.	H_2O	10	Natural, alive.
$n/256$	16	Natural appearance.	H_2O	19	Natural, alive.
$n/256$	17	Natural appearance.	H_2O	18	Natural, alive.
	54	Total growth.		62	Total growth.

We see by reference to the above table that there was a decided growth at $n/256$ and $n/128$ solutions, and when the seedlings were put into distilled water the growth was approximately the same. Thus it is evident that the elongation of the roots was due to actual growth.

In the tests with NaOH the results were similar to those of KOH, from which we might conclude that the toxic action of the two solutions is similar. However, the roots in NaOH $n/64$ had an appearance more nearly natural after each twenty-four hours than the roots in KOH of the same dilution; which suggests that the Na and K ions at this dilution might have some toxic influence and that of the K ions is greater than that of the Na ions.

TABLE II. SOLUTIONS OF NaOH. BEGUN MAY 26, 10 A.M., CLOSED MAY 28, 10 A.M.

Concentration.	Growth in m/m.	Remarks.	Distilled.	Growth in m/m.	Remarks.
$n/32$	0	Flabby.	H_2O	0	Flabby, dead.
$n/32$	0	Flabby.	H_2O	0	Flabby, dead.
$n/64$	1	Probably only elongated. Yellowish.	H_2O	0	Root appears natural except at the tip, dead, (?).
$n/64$	3	Yellowish.	H_2O	0	Root appears natural except at the tip, dead, (?).
$n/128$	12	Growth in a circle. Natural appearance.	H_2O	20	Natural, alive.
$n/128$	20	Natural appearance.	H_2O	30	Natural, alive.
$n/256$	11	Natural appearance.	H_2O	35	Natural, alive.
$n/256$	13	Natural appearance.	H_2O	20	Natural, alive.
	60	Total growth.		105	Total growth.

TABLE III. SOLUTIONS OF HCl. BEGUN JUNE 1, 10 A.M., CLOSED JUNE 3, 10 A.M.

Concentration.	Growth in m/m.	Remarks.	Distilled.	Growth in m/m.	Remarks.
$n/256$	2	Probably only elongated. Roots have pallid appearance.	H_2O	0	Coagulated, dead.
$n/256$	1	Roots have pallid appearance.	H_2O	0	Coagulated, dead.
$n/512$	18	Natural appearance.	H_2O	6	Natural, alive.
$n/512$	15	Natural appearance.	H_2O	21	Natural, alive.
$n/1024$	20	Natural appearance.	H_2O	36	Natural, alive.
$n/1024$	35	Natural appearance.	H_2O	30	Natural, alive.
$n/2048$	25	The root grew in a curve of 180°.	H_2O	20	Completed a circle.
$n/2048$	28	The root grew in a curve of more than 180°.	H_2O	25	Completed the circle then grew straight up.
	146	Total growth.		138	Total growth.

TABLE IV. SOLUTIONS OF H_2SO_4. BEGUN JUNE 4, 10 A.M., CLOSED JUNE 6, 10 A.M.

Concentration.	Growth in mm.	Remarks.	Distilled.	Growth in mm.	Remarks.
$n/256$	3	Natural appearance.	H_2O	0	Dead (?).
$n/256$	3	Natural appearance.	H_2O	0	Dead (?).
$n/512$	48	Natural appearance.	H_2O	40	Natural, alive.
$n/512$	35	Natural appearance.	H_2O	16	Natural, alive.
$n/1,024$	60	Natural appearance.	H_2O		Accident.
$n/1,024$	60	Natural appearance.	H_2O	50	Natural, alive.
$n/2,048$	50	Natural appearance.	H_2O	30	Natural, alive.
$n/2,048$	38	Natural appearance.	H_2O	16	Natural, alive.
	297	Total growth.		152	Total growth.

By comparing the total growth in H_2SO_4 with the total growth in HCl we see that the amount of growth in H_2SO_4 was over twice the total growth in HCl, but the difference in the total growth in H_2O after the seedlings were taken from the acid solutions was but small (20 mm.). This suggests that the ions in the HCl solutions produce a greater toxic effect upon the seedlings than those of H_2SO_4.

By comparison of the above tables we see that at the dilutions of the compounds used, the toxic effects of KOH and NaOH are practically the same, and the toxic effects of HCl and H_2SO are *approximately* the same.

In regard to the degree of dissociation of strong bases Arrhenius says:* "In the saponi-

* Arrhenius, 'Text-Book of Electro-Chemistry,' p. 184.

fication of bases it has been found that all strong bases exert about the same action. The velocity of reaction at 9°.4 is:

NaOH	2.31	$Sr(OH)_2$	2.20
KOH	2.30	$Ba(OH)_2$	2.14
$Ca(OH)_2$	2.29		

The numbers are for 1/40 normal solutions, in which the strong bases may be regarded as completely dissociated." As the dilution of the alkali at which death was produced was much greater the dissociation must have been complete, hence the death must have been caused by the OH and Na or K ions. And as the total growth of the seedlings in KOH solutions is nearly equal to the total growth in NaOH solutions, we can conclude that the toxic effect of Na ions is approximately equal to the toxic effect of K ions.

From a table of electrical conductivity* the degree of dissociation of HCl at $n/256$ was found to be 98.9, at $n/512$ it was found to be 99.5. The degree of dissociation of H_2SO_4 at $n/256$ was found to be 91, at $n/512$ it was found to be 95.6.

By comparing the dilutions at which the seedlings were found dead with the degree of dissociation given above it will be seen that there is quite a difference between the degrees of dissociation at the strength of the two solutions (HCl and H_2SO_4). While at the greatest dilution in which the seedlings lived in both solutions the difference is not so great. This difference in the degree of dissociation was manifest in the difference in the total growth of the seedlings in the different solutions; the solution less dissociated producing the greater total growth.

Thus we see that the corn seedling lived and grew in a $n/128$ solution of KOH and NaOH, and in $n/512$ solution of HCl and H_2SO_4. While Kahlenberg and True showed that a seedling of *Lupinus albus* L. just lived in $n/400$ solution of KOH and in $n/6,400$ solution of HCl. This shows that corn seedlings lived in a solution of KOH more than three times as strong, and in a solution of HCl more than twelve times as strong, as that in which the seedling of *Lupinus albus* just lived.

* Arrhenius, *l. c.*, p. 135.

Although a seedling of a widely different species was used by Kahlenberg and True, yet it is remarkable that the corn seedling should resist the toxic effect of OH ions in a solution three times as concentrated, and that it should resist H ions in another solution twelve times as concentrated.

If the difference between the effects of the OH ions in one case is three times, why should we not expect the difference between the effects of the H ions in the other case to be about three times also? It seems logical to expect that the ratio between the effects of like solutions upon two different seedlings would be about the same in any solution.

It is my purpose to continue the investigation of this problem to find the exact dilution in which the seedling will just live; and how this death limit varies with different seedlings.

FRED A. LOEW.

AGRICULTURAL COLLEGE, MICH.,
June 16, 1903.

THE SPONGY TISSUE OF STRASBURGER.

MANY students of the gymnosperms have commented upon the peculiar structure of the cells immediately surrounding the female gametophyte during the period of its development. Both Hofmeister* and Strasburger† believed that two prothallia were formed in those members of the Abieteæ which require two years for the maturation of their seeds. They thought that the first or transitory prothallium was characterized by thickened cell-walls and that this cellular body was dissolved in the spring, giving place to the true or normal prothallium.

In 1879 Strasburger‡ established the fact of the existence of a single prothallium in the Abieteæ, and described a band of loosened

* Hofmeister, 'Vergleichende Untersuchungen höherer Kryptogamen und der Samenbildung der Coniferen,' 1851.

† Strasburger, 'Die Befruchtung bei den Coniferen,' 1869. 'Ueber Befruchtung und Zelltheilung,' 1878.

‡ Strasburger, 'Die Angiospermen und die Gymnospermen,' 1879.